

Solutions - Chapter 16

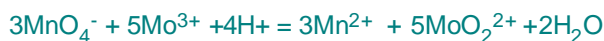
14. First balance the redox equation;



MnO_4^- reduces, Mo^{3+} oxidizes. Inspection of the resulting species prompts the need for H^+ ions, the half reactions are



overall: 3(1) + 5(2)



Titration data: $V_{\text{Mo}} := 25.00$ $V_{\text{MnO}_4\text{blank}} := 0.04$
 $V_{\text{MnO}_4} := 16.43$
 $M_{\text{MnO}_4} := 0.01033$

From the stoichiometry:
$$\frac{V_{\text{Mo}} \cdot M_{\text{Mo}}}{V_{\text{MnO}_4} \cdot M_{\text{MnO}_4} - V_{\text{MnO}_4\text{blank}} \cdot M_{\text{MnO}_4}} = \frac{5}{3}$$

has solution(s)

$$M_{\text{Mo}} := \frac{5}{(3 \cdot V_{\text{Mo}})} \cdot (V_{\text{MnO}_4} \cdot M_{\text{MnO}_4} - V_{\text{MnO}_4\text{blank}} \cdot M_{\text{MnO}_4})$$

$$M_{\text{Mo}} = 0.011$$

17. The overall reaction is between permanganate and oxalate, the half reactions are;



Using the stoichiometry with;

$$V_{\text{MnO}_4} := 18.04 \quad M_{\text{MnO}_4} := 0.006363 \quad V_{\text{La}} := 50.00$$

$$\frac{V_{\text{MnO}_4} \cdot M_{\text{MnO}_4}}{\text{mole}_{\text{oxalate}}} = \frac{2}{5}$$

$$\text{mole}_{\text{oxalate}} := \frac{5}{2} \cdot V_{\text{MnO}_4} \cdot M_{\text{MnO}_4} \quad \text{mole}_{\text{oxalate}} = 0.287$$

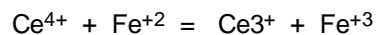
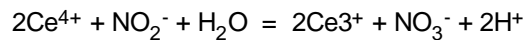
Because every three oxalate ions are associated with two La ions,

$$\text{mole}_{\text{La}} := \frac{2}{3} \cdot \text{mole}_{\text{oxalate}}$$

$$M_{\text{La}} := \frac{\text{mole}_{\text{La}}}{V_{\text{La}}} \quad M_{\text{La}} = 3.826 \times 10^{-3}$$

19. Total ml of Ce(IV) added ..; $V_{\text{Ce}} := 50.00$ $M_{\text{Ce}} := 0.1186$

Volume of Fe(II) (ml) for back titration ..; $V_{\text{Fe}} := 31.13$ $M_{\text{Fe}} := 0.04289$



Because Fe(II) vs Ce(IV) reaction is a 1:1 reaction, the leftover Ce(IV) after the reaction with nitrite ion and mmoles of Ce(IV) reacted with nitrite are;

$$\text{mmoleCe}_{\text{excess}} := V_{\text{Fe}} \cdot M_{\text{Fe}}$$

$$\text{mmoleCe}_{\text{reacted}} := V_{\text{Ce}} \cdot M_{\text{Ce}} - \text{mmoleCe}_{\text{excess}}$$

Ce(IV) : nitrite = 2:1 from the stoichiometry, for the 25.00 ml of the sample (of a 500ml solution)

$$\frac{\text{mmoleCe}_{\text{reacted}}}{\text{mmoleNO}_2_{\text{reacted}}} = \frac{2}{1}$$

$$\text{mmoleNO}_2_{\text{reacted}} := \frac{1}{2} \cdot \text{mmoleCe}_{\text{reacted}}$$

$$\text{mass}_{\text{NaNO}_2} := \text{mmoleNO}_2_{\text{reacted}} \cdot 10^{-3} \cdot 68.995$$

In 500ml the total sample was dissolved.

$$\% \text{mass}_{\text{NaNO}_2} := \frac{\text{mass}_{\text{NaNO}_2} \cdot \frac{500}{25}}{4.030} \cdot 100 \quad \% \text{mass}_{\text{NaNO}_2} = 78.665$$

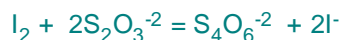
33. Al(III) is precipitated quantitatively as Al(oxine)₃(s) (**Al:oxine = 1:3**).

Redissolved ppt. to generate oxine and was eventually reacted with excess bromine (made in situ by reacting bromide with bromate in acidic conditions) oxine: bromine = 1:2.

Bromine is produced from bromate - **Bromate:Br₂ = 1:3**

Excess bromine was reduced with iodide, this reaction produces iodine. **Br₂:I₂ = 1:1**

I₂ reacts with S₂O₃⁻² quantitatively (iodine:thiosulfate = 1:2);



$$V_{\text{S}_2\text{O}_3} := 8.83 \quad M_{\text{S}_2\text{O}_3} := 0.05113$$

$$\text{mmoles of bromine generated by bromate, bromide rxn} \quad \text{mmoles added}_{\text{Br}_2} := 3 \cdot 25.00 \cdot 0.0200$$

mmoles of iodine reacted at the final stage;

$$\frac{\text{mmoles}_{\text{I}_2}}{V_{\text{S}_2\text{O}_3} \cdot M_{\text{S}_2\text{O}_3}} = \frac{1}{2} \quad \text{mmoles}_{\text{I}_2} := \frac{1}{2} \cdot V_{\text{S}_2\text{O}_3} \cdot M_{\text{S}_2\text{O}_3}$$

Using the stoichiometries given above unreacted (excess) bromine;

$$\text{mmoles Br}_2_{\text{excess}} := \text{mmoles}_{\text{I}_2}$$

mmoles of bromine consumed for the oxine reaction

$$\text{mmoles}_{\text{Br}_2} := \text{mmoles added}_{\text{Br}_2} - \text{mmoles Br}_2_{\text{excess}}$$

Also;

$$\text{mmoles}_{\text{oxine}} := \frac{1}{2} \cdot \text{mmoles}_{\text{Br}_2}$$

$$\text{mmoles}_{\text{Al}} := \frac{1}{3} \cdot \text{mmoles}_{\text{oxine}}$$

$$\text{mgmass}_{\text{Al}} := \text{mmoles}_{\text{Al}} \cdot 26.981$$

$$\text{mgmass}_{\text{Al}} = 5.73$$